

Lorentzian versus Einsteinian relativity as a philosophical issue

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Summary: The contradiction between Einsteinian and Lorentzian theories of relativity concerns the basic structure of the physical reality: while the former rejects the possibility of any privileged reference system, the latter is exactly based on the assumption of such a system. Consequently, despite the general recognition of the philosophical aspect of the issue, the theory-choice between these two different explanations of relativistic phenomena is believed to be a matter of physics, a problem which should be investigated and solved by physicists.

In our paper we will argue against this view and show that while the difference between Lorentzian and Einsteinian theories really is of physical nature, it is only a physical manifestation of philosophical principles of the physicists. The Lorentzian theory of relativity relies on and supports traditional notions of scientific rationality, whereas the Einsteinian theory - in the name of a version of positivist, methodological rationalism - breaks with these conventions. From the point of view of empirical adequacy introduction of a privileged reference system is arbitrary and unnecessary and this conveys support for Einstein's theory. However, in a wider context of the history of science, the introduction of the privileged reference system appears as reasonable. It is in accordance with the methodology of science since it facilitates a rational physical explanation of relativistic phenomena in the traditional sense of the term "rational" and serves to reconcile relativity theory with traditional scientific rationalism. In short, acceptance or rejection of a privileged reference system is based on different philosophical views of rationality. Consequently, the theory-choice between the two theories depends on a kind of rationalism to which the theorists are committed to, and is, therefore, basically not a physical but a philosophical issue.

Key words: underdetermination, theory of relativity, Einstein, Lorentz, privileged reference system, foundations of physics, scientific rationalism

Extended abstract

As it is well known in the philosophy of physics, the various explanations of relativistic phenomena can be subsumed under two classes. One denies the possibility of privileged reference systems, the other postulates the existence of a physically privileged reference system and explains the relativistic phenomena with its help. While the first class is represented by Einstein's original theory and its most recent formulations, the second involves the Lorentzian, ether-based interpretations of relativity theory as well as theories which while rejecting the Lorentzian ether, introduce an alternative, non ether-based privileged system. For simplicity, we will refer to the theories belonging to this second class as Lorentzian interpretations or Lorentzian-type theories independently of whether they establish the privileged reference system by the introduction of the ether (as Lorentz did it) or does it in a different way. [The main stream of various Lorentz-like interpretations are connected to H. Ives, regularly cited in the Anglo-Saxon literature and characterized by M. C. Duffy as the "Ives Group" of Lorentzian theories (Duffy 2008). Duffy lists the representatives of this

group of theories as H. Ives, G. Builder, S. V. M. Clube, H. Erlichson, J. Levy, S. J. Prokhovnik and F. Wintenberg. (ibid. pp. 23, 30). He also mentions a Hungarian physicist, Lajos Jánosy (ibid. p. 32), who did not belong to this group but who not only worked out one of the most comprehensive and mathematically most elaborated Lorentzian theory, but also provided a clear metatheoretical foundation of this kind of interpretations (Jánosy 1971; Székely 2009). Unfortunately, Jánosy's work is unfairly ignored by the members of the "Ives Group" and other Anglo-Saxon authors working on the topic. He had nevertheless a great influence as it is indicated by the acknowledgments to him by such significant authors as Bell and Brown (Bell 1976, Brown 2005, vii.). Among the representatives of the Lorentz-like theories it can be also mentioned a recent Hungarian physicist/philosopher L. E. Szabó. (Szabó 2010)]

Due to its different point of view regarding the physical possibility of privileged reference systems, the Lorentzian-type theory of relativistic phenomena suggests a physical ontology which radically contradicts to Einstein's theory: while in the latter there is no place for any privileged system, the Lorentzian-type explanation is based exactly on the introduction of such a system. Not to say that Einstein's theory excludes the privileged systems in one of its fundamental axioms and this especially sharpens the conflict between the Einsteinian and Lorentzian physics.

The possibility of the Lorentzian and Einsteinian (contradictory) theories emerges from the so-called *Duhem-Quine-Lakatos thesis*, which claims that scientific theories are underdetermined by empirical evidence. The coexistence of these two - Einsteinian and Lorentzian - interpretations of relativistic phenomena is a demonstrative and yet unusual example of the empirical underdetermination of scientific theories, in that they not only cover the same set of data but they do so using the same (Einsteinian-Lorentzian) mathematical formalism. Its implication for philosophy of science is not only the underdetermination in its usual form - i.e., the observation that rival theories may explain the same body of evidence equally well - , but a more radical conclusion also follows from it, namely, the possibility of constructing radically different physical interpretations of the same mathematical formulas. The empirical equivalence between the two interpretations of the Lorentzian-Einsteinian mathematical formalism excludes the applicability of empirical arguments for Einstein and against Lorentz, since all evidence confirming Einstein's theory also confirms the Lorentzian one. Furthermore, not only empirical but any physical (even pure, theoretico-physical) reasoning is inapplicable in this regard: the two interpretations define different physical realities and the point of the debate is exactly the nature of physical reality. Both theories exclude in advance the fundamental physical postulate of the other which prevents any neutral physical arguments between them. Therefore (in sharp contrast to the often emphasized view that the Einstein-Lorentz debate should be settled inside physics) any arguments for or against these interpretations must pertain to a metatheoretical level.

This Duhem-Quine-Lakatos thesis is well known and often cited in history and philosophy of science. However, it has a significant consequence which is seldom emphasized. If there is a gap between theory and the data which the theory refers to, then this gap need to be bridged with non-empirical, extra-scientific elements. The Duhem-Quine-Lakatos thesis, formulated from the point of view of empirical research, states that for any given body of evidence confirming a theory, there might be other theories that are also confirmed by that same body of evidence, and that these theories might well be incompatible with each other. The thesis can be formulated from the other side of the coin, i.e., theory construction. Since empirical

data alone do not determine the theory, any scientific theory necessarily contains “arbitrary” elements, elements that do not come from empirics. This interpretation of the Duhem-Quine-Lakatos thesis invites the question: where do the non-empirical elements come from? To put it differently: what are the factors that determine these empirically un-determined elements of scientific theories?

In what follows, first we will investigate this question from a general, philosophical point of view and then we will apply our results to the particular case of the co-existence of the Lorentzian and Einsteinian theories.

The way one answers the questions of theory choice of parallel theories relating to the same empirical evidence depends on the type of philosophy and of philosophy of science one is committed to. The possible positions taken in this respect are divided along two lines. Decisive is the epistemic role attributed to empirical data, and the methodological function attributed to induction. In a traditional empiricist manner, we can say that the goal of science is not creating true theories but creating theories which are empirically adequate (e.g. van Fraassen 1980). In this framework, for a given set of data we can have a range of empirically adequate theories which are incompatible with each other. One of us (Ropolyi 2004; 2006) has argued before that all scientific theories have technical and philosophical components. The technical component is the knowledge that pertains to the specific situation and facilitates its manipulation. The philosophical component consists of the principles of philosophy, which facilitates generalization, i.e., the elevation of the situation-specific knowledge to a universal status. The problem with the argument of van Fraassen and with empiricism in general is that they do not acknowledge anything but empirics and induction as legitimate elements in theory construction. However, given the problem of induction (logically speaking, induction is not a valid method for establishing universal claims); universal statements are not and cannot be established by inductive method. Therefore, in empiricist philosophies of science, science is denied an important function: providing us with theories that are justly regarded as true and serve as the ontology of the world. If science is denied this function, it is reduced to pure technology; scientific theories become mere technological devices (logico-linguistic tools) designed for the successful manipulation of sensory experience and of the situations where they emerge.

If we want scientific theories to fulfill their role in building worldviews, we have to leave the realm of pure empiricism and anchor the general validity of the empirical data in some non-empirical arguments. In other words, the method of induction must be complemented with at least one theoretical (non-empirical) component which establishes the universal status of the claims obtained with the method of induction. This component or presupposition with which the gap between the contingency of empirical data and the universality of scientific claims is bridged can be many things: philosophical principles, mathematical or logical claims, methodological rules, universal values, ideologies, etc. Different research traditions and individual scientists are committed to different values, principles, and ideologies, and this leads to the emergence of partly or fully different scientific theories.

Historians and philosophers of science have tried to identify such choices in past and present scientific practice. According to hermeneutic philosophy of science, the metatheoretical and metaphysical components of scientific theories originate in the scientist's life-world. For social constructivism, they are rooted in the social interests and values of the social groups the scientists belong to. In this paper, we shall combine these approaches and use their respective

methodologies to find the presuppositions used by the Lorentzian and the Einsteinian theories of relativity to bridge the gap between theory and evidence.

With respect to metatheory or criteria of theory choice, the adherents of Einstein's theory emphasize the logical elegance, conceptual simplicity (Occam's razor!) and the compactness – "rational beautifulness" – of the theory. (This is a typical argument in the received physics which can be traced back to as early as Laue work on special relativity published in 1911 (Laue 1919).) In their view, Lorentz-like theories are devoid of logical elegance. Furthermore, the Lorentzian interpretation is said to be based on an empirically inaccessible, "metaphysical" entity (the privileged reference system) and on an empirically indemonstrable process (the Lorentzian deformation of clocks and rods). Lorentzians condemn Einstein's theory for its basic concepts and terms being counterintuitive, absurd and in conflict with everyday notions of space, time and motion. (See e.g. Ives 1979; Jánosy: introduction to Jánosy and Elek 1953; Turner and Hazelett 1979; Székely 1987; 1988) Furthermore, it is claimed that Einstein confuses the measurable properties of physical entities and the mathematical formalism of his theory with physical reality and although his theory successfully deduces the relativistic phenomena from several simple axioms, it does not give a genuine physical explanation. (E. g. Jánosy 1971; Brown 2005) That is, both sides claim that the theory preferred by the other side violates standards of scientific rationality.

As a consequence, the debate between the Einsteinian and Lorentzian theories about the existence or otherwise of a privileged reference system is not about physics but about rationality in general, and about scientific rationality in particular. The arguments in favour of Einstein's theory are based on a particular notion of rationality, which abandons the traditional concepts of space, time and motion in favour of logical simplicity and elegance. Relying on Occam's razor, it argues for a positivist-empiricist view of science and against traditional physical realism. That is, in Einstein's relativity theory, physical reality is determined by an aesthetic-logical concept of rationality. The theory focuses on formal structure and takes an "anti-metaphysical", positivist methodological point of view, which originated in the second half of the 19th century and was mediated to Einstein by Ernst Mach.

In contrast, Lorentz and his adherents defend a substantive version of rationality, which beyond formal-logical beauty also considers the content of the theory and rejects any theoretical elements which are counterintuitive. It is furthermore committed to traditional realism which distinguishes observables and theoretical entities, on the one hand, and physical reality, on the other, and rejects the hypostatization of theoretical terms and mathematical constructions. Both substantive rationalism and traditional realism are features that have characterized modern science since its origins. The Lorentzian theory of relativity relies on and supports traditional notions of scientific rationality, whereas the Einsteinian theory of relativity breaks with these conventions.

For this reason, Einstein's theory of relativity is often considered to have brought about a revolution not only in physics but also with respect to the scientific worldview and standards of scientific rationality. This is indeed true in a certain sense, but the argument confuses cause and effect. If the terms and concepts of Einstein's relativity theory contradict both our basic intuitions about physical reality and the criteria of traditional rationality, this is because the theory was born out of a conscious abandonment of traditional rationality in favor of a positivist methodology and logical elegance. The criteria used to assess the merits of the Einsteinian and of the Lorentzian relativities are not independent from these metatheoretical

commitments and philosophical values. Both the Einsteinian and the Lorentzian versions perform better on the metatheoretical criteria that they themselves set for scientific theories. The philosophical significance of the Einsteinian relativity lies in its positivism (i.e., it does not wish to postulate the existence of entities which are not directly observable) and elegance, whereas the philosophical significance of the Lorentz-like interpretations lies in the fact that they are in harmony with the norms of traditional scientific rationalism. From an empiricist-positivist point of view, the introduction of the privileged reference system is arbitrary, ad hoc, and therefore, irrational. From the point of view of traditional realism, however, the introduction of the privileged reference system is perfectly reasonable and even necessary, as it enables the theory to elaborate a rational physical explanation of relativistic phenomena and to thus fulfill criteria of scientific rationality in the traditional sense.

In the light of the underdetermination thesis, it is clear that at the present moment the choice between the two competing theories is not only a theory choice, but also a choice between their methodological and metatheoretical commitments. On the other hand, the relation of the two theories is not symmetric. While all evidence which corroborates Einstein also corroborates Lorentz, it is theoretically possible such empirical data which are in conformity with Lorentz-like theories but contradicts to Einstein's predictions. If such data will really emerge, then it will be an open question whether the Einsteinian theory of relativity will be able to adapt itself to this situation with the help of auxiliary hypotheses or will break down.

Until such data will emerge the debate between the two characteristic physical interpretations of the Einsteinian-Lorentzian mathematical formalism cannot be settled within physics: the preference of the one against the other will be the function of a value choice. What is at stake in this value choice is whether the long-standing tradition of scientific rationalism should be continued or abandoned. A considerable part of the physics community favours the latter why a minority insists on the former. As Feyerabend put it, "The choice of our basic cosmology may become a matter of taste." (Feyerabend 1970) Of course, this does not mean arbitrariness; theory choice should happen in accordance with our metatheoretical commitments. If we insist on the criteria of substantive rationality and traditional realism, we cannot accept Einstein's theory but need to introduce a privileged reference system. If, however, we do not want to introduce an entity which has no observable consequences, then we are compelled to abandon substantive rationalism and traditional realism, and accept the absurd spatial and temporal notions of the Einsteinian theory.

In the pre-relativistic period of the history of science, substantive rationalism and traditional realism, on the one hand, and logical beauty and Occam's razor, on the other hand, seemed to be reconcilable. In the age of the theory of relativity, however, these are conflicting requirements. The contradiction between the Einsteinian and the Lorentzian theories of relativity arises from this conflict between the substantive and methodological elements of classical rationality arising in the context of the 20th century physics: the debate between the two theories is not simply about physics but about the preference of the criteria of rationality to be applied in science. As a consequence, it is basically a philosophical and not a physical issue and this situation may be changed only if Einstein's theory will be falsified in such a way that will not falsify the Lorentzian one.

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